Conclusion: use of estradiol improves ossification capacity in vitro and promote tendon to bone healing after anterior cruciate ligament reconstruction in vivo.
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B0218

Percutaneus repair of Achilles tendon rupture under ultrasound surveillance as effective method of treatment in patients with other diseases

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Background: Open repair of torn Achilles tendon is a standard procedure, however complications may occure due to extensive approach, especially in older patients with general conditions. Different systems for minimally invasive procedures were also introduced but the risk of damaging sural nerve was pointed out.
Aims: We developed percutaneus repair of Achilles tendon rupture under ultrasound surveillance and assessed safety and results of the procedure.
Methods: Since May 2011 until September 2015 we performed 14 procedures. The tendons were repaired with Ethibond suture loop passed through the tendon below and above rupture through the skin with elastic needle under direct ultrasound visualization.
We analized results of patients with minimally 3 months follow up. Some of patients were also burden with diabetes, cardiac diseases, psychiatric disorders and thrombocytopenia. We qualified for treatment only acute ruptures (up to 10 days), with relative contraindications for open procedures.
Results: We assessed function of repaired tendon in clinical examination and ultrasound exam 6 weeks and three months after surgery. Also AOFAS score was used.
13 of 14 patients healed tendon and returned to their activities. In one case conversion to open surgery was necessary as patient experienced another trauma in postoperative period. Another patient reported persisting pain due to suture conflict with soft tissues. Release of the suture was necessary six months after surgery. There was no sural nerve entrapement nor skin healing problems. AOFAS score raised from 57,8 to 92,8 three months after surgery.
Conclusions: Percutaneus repair of Achilles tendon rupture under ultrasound surveillance is minimally invasive and effective method of treatment of acute ruptures. It is safe and allows to avoid both sural nerve entrapement and skin healing problems. However, it requires some experience with ultrasound diagnostics.
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B0220

Open wedge high tibial osteotomy using three-dimensional printing model: Experimental analysis using porcine bone

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The purpose of this study was to evaluate the usefulness of a three-dimensional (3D) printing model for open wedge high tibial osteotomy (HTO) in patients with medial knee osteoarthritis. Computed tomography (CT) images were obtained from 10 extended porcine knees and 3D imaging was planned using the 3D-Slicer program. The osteotomy line was drawn from the predicted medial osteotomy site (approximately 3 cm below the medial tibial plateau) to the hinge point, the proximal end of the fibular head. After the osteotomy, the osteotomy gap was opened until the mechanical axis line connecting the hip and ankle joint centers was 62.5% from the medial border along the longest medial-to-lateral width of the tibial plateau maintaining the posterior tibial slope angle. The wedge-shaped 3D printing model was designed with the measured angle and osteotomy section and was produced by the 3D printer. The open wedge HTO surgery was reproduced in porcine bone using the 3D printing model and the osteotomy site was fixed with a plate. Accuracy of osteotomy and posterior tibial slope was evaluated after the osteotomy. The mean mechanical axis line on the tibial plateau was $61.8 \pm 1.5\%$ from the medial tibia. There was no statistically significant difference ($p = 0.160$). The planned and post-osteotomy correction wedge angles were $11.5 \pm 3.2^\circ$ and $11.4 \pm 3.3^\circ$, and the posterior tibial slope angle was $11.2 \pm 2.2^\circ$ pre-osteotomy and $11.4 \pm 2.5^\circ$ post-osteotomy. There were no statistically significant differences ($p = 0.854$ and $p = 0.429$, respectively). This study could obtain good results of high tibial osteotomy using 3D printing model in porcine legs. Therefore, this method can be applied later to open wedge high tibial osteotomy clinically in human.
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B0228

Chondral lesions with medial meniscal posterior root tear are located more medially and more progressive than those with other meniscal tears

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Introduction: Medial meniscal posterior root tear (MMPRT) is associated with development or worsening of medial tibiofemoral cartilage damage. The purpose of this study is to demonstrate the characteristics of chondral lesion on the medial femoral condyle (MFC) in patients with MMPRT.

Materials and Methods: Fifteen patients who underwent arthroscopic repair of MMPRT from August 2014 to July 2015 were included. Chondral lesions of the medial femoral condyle on preoperative MRI and arthroscopic finding were recorded according to ICRS - articular cartilage injury classification and mapping system. The incidence of grade 3 or above chondral lesion on each compartment was compared between the findings on MRI and arthroscopy. And the incidence of grade 2 or above chondral lesion and the location of first lesion (most severely injured) on arthroscopic findings were compared between the MMPRT group and the patients group who underwent arthroscopic surgery for degenerative medial meniscus posterior horn (MMPH) tear other than MMPRT during the same period as the control.
Results: Arthroscopic findings of 13 patients (86.7%) exhibited grade 3 or above chondral lesion on the MFC, whereas it is exhibited on only 8 preoperative MRI (53.3%). The incidence of chondral lesion in central-medial compartment showed significant difference between the findings on MRI and arthroscopy (26.7% *vs* 66.7%, $p < 0.05$), and the difference between MRI and arthroscopy is significantly correlated with the day from the taking MRI to the surgery (Pearson's correlation coefficient = 0.659, $p = 0.008$). All 15 patients with the MMPRT had the ICRS grade $\geq$ 2 chondral injuries at medial compartment, whereas only 23 of 69 patients (33.3%) in control group had the grade $\geq$ 2 injuries. In MMPRT group, central-medial compartment is most frequently affected (N=17, 73.3%), whereas central-central compartment is major affected site in control group (N=13, 56.5%). This injury pattern showed statistically significant difference between two groups (p=0.004).
Conclusion: Chondral lesions on MFC developed in patients with MMPRT are located more medially than those in patients with degenerative MMPH tear other than root tear, and these lesions are more likely to develop with the time. Early intervention should be considered in patients who exhibiting MMPRT, to prevent the development of these lesions.
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B0236

Relationship between tunnel malposition and intra-articular degeneration in anterior cruciate ligament reconstruction

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Background: To elucidate the relationship between radiographic tunnel position parameters in primary anterior cruciate ligament (ACL) reconstruction and arthroscopic findings of cartilage degeneration or bucket-handle meniscal tear using arthroscopy in revision surgery.
Materials and Methods: Thirty-five patients who underwent ACL revision reconstructions were recruited; their primary surgeries were single-bundle reconstructions. Tunnel positions of primary reconstructions were evaluated using the plain radiograph prepared before revision surgery. The sagittal tunnel positions (%) of the femur (FP) and tibia (TP) were determined on the lateral view. To evaluate the tunnel angle, the line connecting the midpoint of the femoral and tibial tunnel aperture was drawn to divide a line parallel to the tibial plateau on the coronal view. Articular cartilage was evaluated arthroscopically by International Cartilage Repair Society (ICRS) grade at primary surgery and at revision surgery, and two-grade progression was defined as cartilage degeneration. The bucket-handle meniscal tear was also evaluated by probing. Logistic regression analysis was conducted using the prevalence of cartilage degeneration or bucket-handle meniscal tear as the dependent variable; tunnel parameters, including sex and the duration (months) from primary surgery to revision surgery, were used as the independent variables.
Results: Seven patients (20.0%) had cartilage degeneration and nine patients (25.7%) had bucket-handle meniscal tear in their medial meniscus. In logistic regression models, %FP [odds ratio (OR): 1.547; P=0.089] was not correlated with cartilage degeneration, whereas the cut-off of 59% in the FP (OR: 14.859; P=0.027) was significantly correlated with cartilage degeneration. On the contrary, %TP (OR: 1.204; P=0.026) was significantly correlated with the prevalence of bucket-handle meniscal tear.
Discussion: While there are substantial evidences of the tunnel position on the femoral side, it is less debated on the tibial side. Limited studies have mentioned how posterior tunnel malposition on the tibial side affected the biomechanical or clinical outcome in ACL reconstruction. One important biomechanical function of menisci is to stabilize the ACL-deficient knee. During chronic ACL deficiency, menisci always are in danger of the bucket-handle meniscus tear, which occurs with continuous episodes of giving way. In accordance with the current data, posterior tibial tunnel malposition can induce clinical and biomechanical burdens on the medial meniscus.
Conclusion: In our revision series, anterior femoral tunnel malposition in the femur affected the definitive cartilage degeneration, and posterior tibial tunnel malposition resulted in the prevalence of bucket-handle meniscal tear.
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B0237

Relationship between humeral torsion and career of pitcher in elementary and junior-high schools

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Background: Repetitive throwing motion generates tremendous stress on the dominant shoulder in baseball players, resulting in osseous change in the shoulder joint, especially increased humeral retroversion. Here we hypothesized that the career of a pitcher in elementary and junior-high

schools might increase humeral torsion on the dominant shoulder. The objective of this study was to assess the effect of baseball position in youth and adolescent athletes on humeral torsion.
Materials and Methods: We studied 153 high school baseball players who began to play baseball in elementary school at the age of 8.1 ± 1.6 years old. All subjects completed questionnaires about their baseball experience, throwing activity, and past injuries; they then were physically examined. We divided them into four groups according to their baseball positions in elementary and junior-high schools: 35 players were pitchers in both elementary and junior-high school (group 1), 32 players were pitchers in elementary school but fielders in junior-high school (group 2), 17 players were fielders in elementary school but pitchers in junior-high school (group 3), and 69 players were fielders in both elementary and junior-high school (group 4). Humeral torsion was assessed bilaterally by using ultrasound. Humeral torsion was defined as the angle between the long axis of the forearm and a line parallel to the trunk, when the line tangential to the bicipital groove was parallel to the horizontal baseline in supine position with the shoulder at 90° abduction, the elbow at 90° flexion, and the forearm in the neutral position.
Results: Beginning age of baseball did not differ significantly among four groups. Among the 153 high school baseball players, 113 players (73.9%) had history of shoulder or elbow injuries. Humeral torsion was significantly greater ($p<0.01$) on the dominant shoulder than on the non-dominant shoulder in all groups. Humeral torsion on the dominant shoulder was significantly greater ($p=0.03$) in group 1 than in group 4 (mean difference, 7.1°). A logistic regression analysis showed that humeral torsion on the dominant shoulder was not a predictive factor for shoulder and elbow injuries (odds ratio, 0.99; 95% confidence interval, 0.96 - 1.02; p value, 0.70).
Conclusions: In high school baseball players, humeral torsion was greater on the dominant shoulder than on the non-dominant shoulder. Players who played baseball as pitchers during both elementary and junior-high school had greater humeral torsion on the dominant side than did players who were fielders during both periods. Given that pitchers throws more frequently than do fielders, this study suggests that increased time pitching in youth and adolescent athletes increases the humeral torsion on the dominant shoulder. Increased humeral torsion on the dominant shoulder was not the predictive factor for shoulder and elbow injuries.
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B0239

A comparison of two superficial MCL reconstruction includiing single-bundle anterior cruciate ligament (ACL) reconstruction

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Introduction: Anterior cruciate ligament (ACL) and medial collateral ligament (MCL) are the most commonly injured ligaments in the knee, which serves as the primary medial stabilizer to anterior translation and valgus stress [1]. It is not uncommon for superficial medial collateral ligament (sMCL) damage to occur with ACL injury. While conservative treatment of the MCL injury is often done, in cases of severe injury, reconstruction of the sMCL can be done in addition to the ACL reconstruction. There are two MCL reconstructions (parallel and tri-vector) in clinic. But we don't know which technique can better restore the biomechanics of the intact knee. The objective of the study was to compare knee biomechanics of two sMCL reconstructions combined with single-bundle ACL reconstruction using a porcine model.
Methods: Twenty (n=20) fresh frozen unpaired adult pig knees were used for biomechanical testing. Specimens with a congenital abnormality or arthritis were excluded from the study and the existence of an intact ACL was confirmed arthroscopically. All specimens were frozen at -20 C^0, and thawed the night before testing at room temperature. The knees were kept intact and the specimens were kept moist with physiologic saline solution. The tibia and femur were sectioned ~15 cm from the joint line and the ends of femur and tibia were potted in heavyweight epoxy putty.
The specimens were divided into two groups, tested with the robotic testing system (CASPAR Orto MAQUET, Germany) under (1) an 89-N anterior tibial (AT) load at 30° (porcine full extension), 60°, and 90° of knee flexion, (2) 4-Nm internal and external tibial torques at 30° and 60°, and (3) a 7-Nm valgus torque at 30° and 60° of knee flexion [2, 3]. The groups were divided into either parallel or tri-vector group sMCL reconstruction and both groups had single bundle ACL reconstructions. The ACL reconstructions were performed with a 7 mm graft which was fixed with 60 N at 30° of flexion. The sMCL reconstructions were performed with 6 mm grafts and fixed with 44 N at 30° of flexion. The ACL reconstructions were done arthroscopically in an anatomic fashion with hamstring grafts and graft fixation was done with a screw and washer on the tibia and an extra-cortical button on the femur.
Differences in anterior tibial translation (ATT) displacement, internal / external rotation angles, and in situ forces at the different flexion angles where analyzed using one-way ANOVA with repeated measures, and statistical significance was set at $p < 0.05$.
Results and discussion: With ACL MCL co-injuries, ACL reconstruction alone can't restored ATT, valgus, internal or external rotation result. With ACL and two different sMCL reconstructions, no significant differences were found between two groups for ATT at 30° flexion, and both method restored intact knee biomechanics. At 60° and 90° of flexion, MCL tri-vector reconstruction can restore the ATT, while parallel MCL reconstruction cannot improve the ATT. Under valgus loading, ACL reconstruction alone did not restore intact knee stability, the parallel sMCL reconstruction did restore stability while the tri-vector method did not. Under the external tibial torque, parallel sMCL reconstruction does restore external rotation while tri-vector sMCL reconstruction does not restore. Under the internal tibial torque, both sMCL reconstruction techniques restored intact knee internal rotation.

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B0241

Morphological changes in the femoral tunnel aperture following anatomic MPFL reconstruction

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Background: There has been only one study investigating the femoral tunnel enlargement after medial patellofemoral ligament (MPFL) reconstruction, while tunnel widening after anterior cruciate ligament (ACL) reconstruction is a well-known phenomenon. The purpose of this study was to evaluate the morphological change at the aperture of the femoral tunnel after anatomic MPFL reconstruction with hamstring tendon graft using three dimensional computed tomography. Our hypothesis was that morphological changes including tunnel enlargement would occur in anatomic MPFL reconstructions as in anatomic ACL reconstructions.
Method: From July 2012 to September 2014, 23 patients with recurrent patellar dislocation who performed anatomic MPFL reconstruction were prospectively enrolled in this study. They were 6 males and 17 females with a median age of 24 years (range, 14-53). All study protocols were approved by the local ethics committee. All reconstructions were performed using a modified "dual tunnel MPFL reconstruction" technique, as described previously. Briefly, a semitendinosus tendon autograft was harvested. Then, two patellar bone sockets and one femoral tunnel were created anatomically under X-ray control. Finally, the graft was inserted and fixed with cortical suspension devices. The knee was immobilized for 2 weeks following surgery and weight-bearing was gradually increased to full at 4 weeks. Running was allowed at 3 months, followed by a return to previous sporting activity at 6 months. Computed tomographic scans obtained at two weeks and a year after surgery were reconstructed into 3D constructs using the volume analyzer SYNAPSE VINCENT® (Fujifilm Medical, Tokyo, Japan). Cross sectional areas (CSA) and locations of center, anterior border, posterior border, distal border, and proximal border of the femoral tunnel were compared between the two periods. CSA was measured on the plane perpendicular to long axis of the femoral tunnel. A true medial view of the femur was established by superimposing the posterior aspects of the femoral condyles. The distance (D) from the anterior border to the posterior border of the femoral condyle was defined as 100% and we created coordinate axes. Anterior-to-posterior and proximal-to-distal positions were calculated as percentages of the distance (D). The Wilcoxon signed rank test was used to compare the values of the two periods.
Results: CSAs of the aperture of the femoral tunnel at 2 weeks and 1 year after surgery were 21.7 ± 2.8 mm^2 and 30.3 ± 7.1 mm^2, respectively ($P < 0.01$). The average CSA significantly increased by 41.1 ± 34.7 % (range, -6 - 103 %) at 1 year after surgery compared with 2 weeks after surgery. The center and the anterior border of the femoral tunnel significantly shifted in the anterior direction at 1 year after surgery. The proximal border significantly shifted in both anterior and proximal directions and the distal border shifted in both anterior and distal directions. The posterior border did not significantly shifted.
Discussion: The study revealed two important findings. First was that the CSA of the femoral bone tunnel enlarged in MPFL reconstruction by using 3DCT. Berard et al. reported that 2x tunnel enlargement was noted in 41.8% after MPFL reconstruction using plain X-ray. The finding is in accordance with the current result and tunnel enlargement due to graft tunnel motion, such as the bungee cord effect and windshield wiper effect, would occur in MPFL reconstruction as in ACL reconstruction. The other important finding of the study, which has not been reported previously, was that the tunnel aperture migrated anteriorly with time after surgery. The reason would be that the MPFL mainly functions from 0 to 30°of knee flexion and trochlea is primary restraint with additional flexion.
Conclusion: This is the first study investigating the morphological change of the femoral tunnel following MPFL reconstruction in detail using 3DCT. Surgeons need to take into account the fact that tunnel enlargement occurs in MPFL reconstruction. We believe that the knowledge of this phenomenon will contribute to further development of anatomic MPFL reconstruction. Limitations are as follows: (1) small sample size, (2) investigating only the aperture of the femoral tunnel, and (3) without clinical evaluations.
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B0242

Association of fibrosis in the infrapatellar fat pad and degenerative cartilage change of patellofemoral joint after anterior cruciate ligament reconstruction

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Background: The purpose of this study was to evaluate the prevalence and risk factor of cartilage degeneration of patellofemoral joint (PFJ) that was diagnosed by second look arthroscopy in the short term follow-up period.